Microbial Ecology

Online Lecture

MLT part -II

Objectives

- Get familiar with the basic terms of Microbial Ecology.
- What is Microbial Ecology and how microbes live in association with each other in the environment (soil, water, air, food, etc).
- What is food chain and role of microbes in biosphere.

KEY TERMS

- **Consumers** Organisms that consume organic material and rely on the activities of primary producers.
- **Decomposer**s Organisms that digest the remains of primary producers and consumers.
- **Eutrophic** An environment that is nutrient rich, supporting the excessive growth of algae and other organisms.
- **Hypoxic** An environment very low in dissolved oxygen.
- **Microbial Mat** A type of microbial community characterized by distinct layers of different groups of microbes that together make up a thick, dense, highly organized structure.
- **Oligotrophic** A nutrient-poor environment.
- **Primary Producers** Organisms that convert CO_2 into organic compounds, sustaining other life forms.
- **Rhizosphere** Zone around plant roots containing organic materials exuded by the roots.

Microbial Ecology

Ecology is the study of the relationships of organisms, plant and animal, to each other and to their environment.

Likewise, **Microbial ecology** is the study of the relationships of microorganisms to each other and to their environment.

Living organisms interact with one another in symbiotic relationships, such as:

- Commensalism,
- Mutualism
- Parasitism

Organisms in a given area, the **community,** interact with each other and the non-living environment, forming an ecological system, or **ecosystem.**

Organisms in the Ecosystem

Major ecosystems include:

- The oceans,
- Rivers and lakes,
- Deserts,
- Marshes,
- Grasslands,
- Forests, and tundra.

Each ecosystem possesses a certain spectrum of organisms and characteristic physical conditions.

The region of the earth inhabited by living organisms is called the **biosphere.**

Within the biosphere, ecosystems vary both in **biodiversity** (number and variety of species present and their evenness of distribution) and **biomass** (the weight of all organisms present).

Nutrient Acquisition

- According to the **trophic level,** or the source of food, organisms are categorized into:
  - Primary producers
  - Consumers
  - Decomposers

- These three general trophic levels are intimately related to the cycling of nutrients.

Primary producers are autotrophs.
They convert carbon dioxide into organic materials.

Producers include:

- Photoautotrophs, which use sunlight for energy
- Chemolithoautotrophs, which oxidize inorganic chemicals for energy.

Primary producers serve as a food source for consumers and decomposers.

Examples:

- Plants
- Algae
- Cyanobacteria

Nutrient Acquisition

Consumers are heterotrophs.
Because they utilize organic materials, they rely on the activities of primary producers.

Consumers include:

Herbivores, which eat plants or algae, are **primary consumers.**
Carnivores that eat herbivores are **secondary consumers;**
Carnivores that eat other carnivores are **tertiary consumers.**

This chain of consumption is called a **food chain.** Interacting food chains are called a **food web.**

Decomposers are heterotrophs that digest the remains of primary producers and consumers.
Decomposers specialize in digesting complex materials such as cellulose, converting them into small molecules that can more readily be reused by other organisms.

The complete breakdown of organic molecules into inorganic molecules such as ammonia, sulfates, phosphates, and carbon dioxide is called **mineralization.**

Examples: Microorganisms, particularly bacteria and fungi, play a major role in decomposition processes owing to their ubiquity and unique metabolic capabilities.

Nutrient Acquisition

Soil

Primary producers

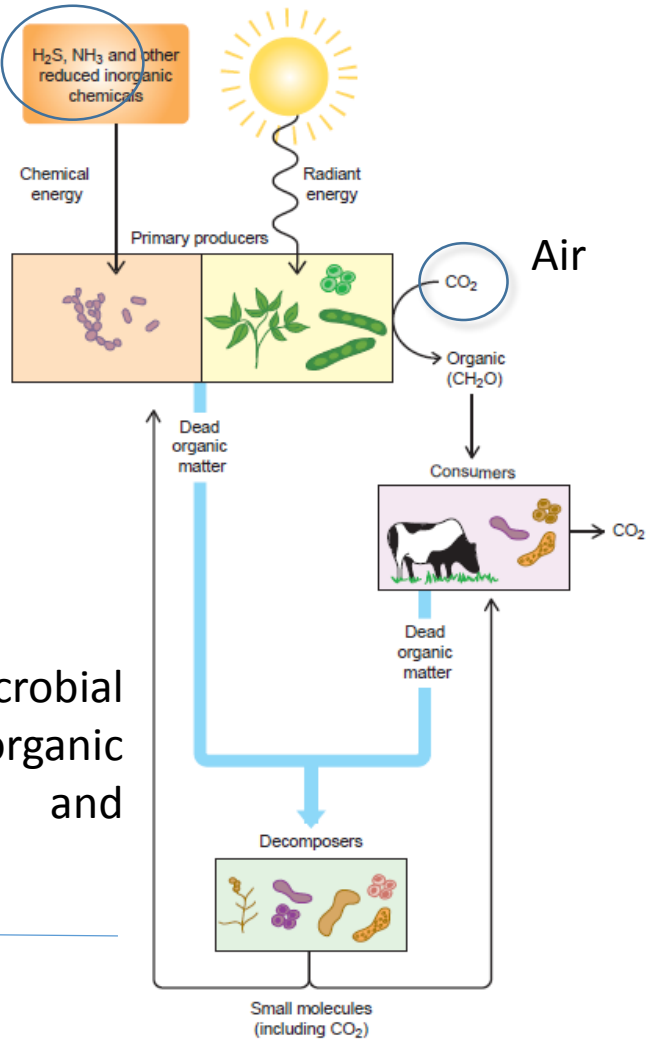
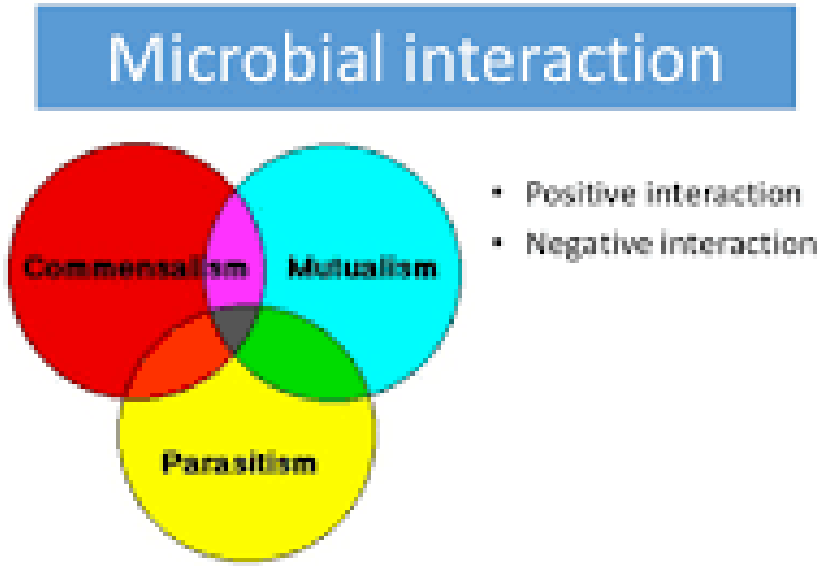


FIGURE 30.1 Relationship Among Primary Producers, Consumers, and Decomposers in an Ecosystem

Decomposition by microbial system produces many inorganic nutrients under aerobic and anaerobic conditions

Association of Microbes



Association of Microorganisms in Ecosystem

SYMBIOSIS

It is two differing organisms living together in a close association that is beneficial to one or both of them.

Examples: mycorrhizal', or mycorrhizal symbionts *(myco* = fungus; *rlliw* = root).

Mycorrhizae function as do root hairs on plants; that is, they extend the surface area through which the plant can absorb nutrients, especially phosphorus, which is not very mobile in soil.

Commensalism is a type of symbiotic **relationship** in which one species benefits, while the other species is neither harmed nor helped.

Commensal bacteria act on the host's immune system to induce protective responses that prevent colonization and invasion by pathogens. On the other hand, these **bacteria** can directly inhibit the growth of respiratory pathogens by producing antimicrobial products/signals and competing for nutrients and adhesion sites.

Commensal bacteria

- **Commensal bacteria** provide the host with essential nutrients.
  - They metabolize indigestible compounds (Probiotics, for example).
  - They defend against colonization of opportunistic pathogens and contribute to the development of the intestinal architecture as well as stimulation of the immune system among others.

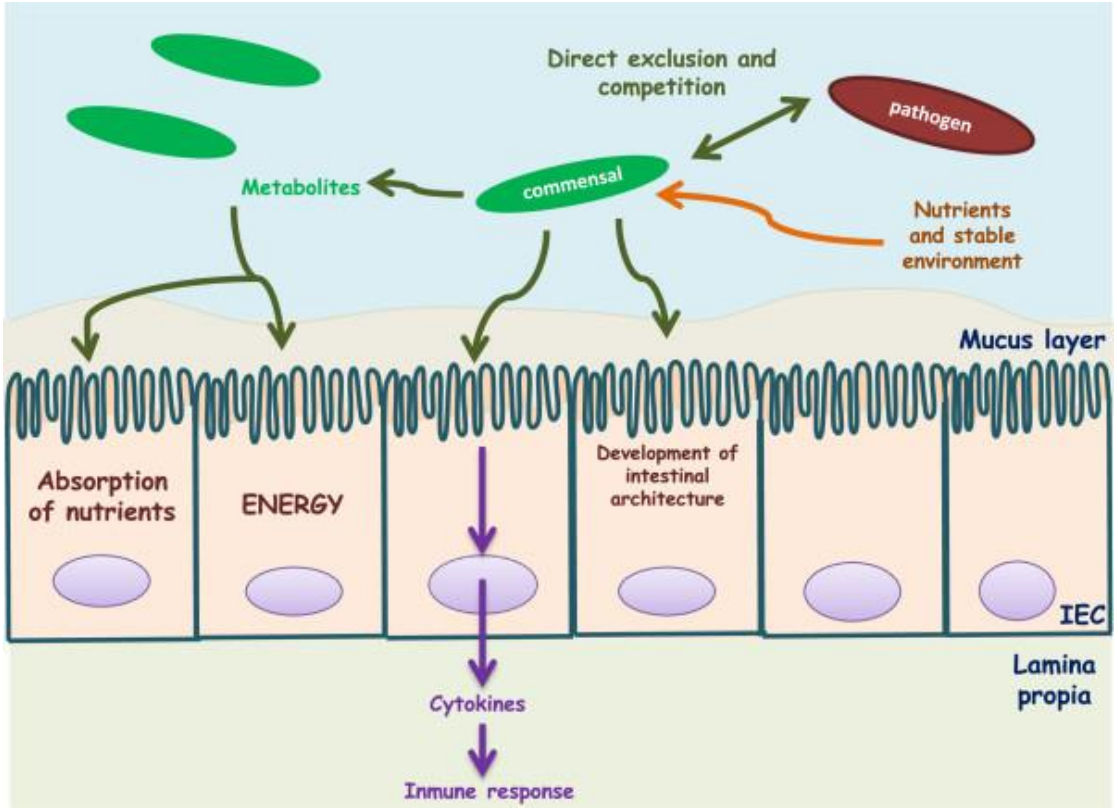
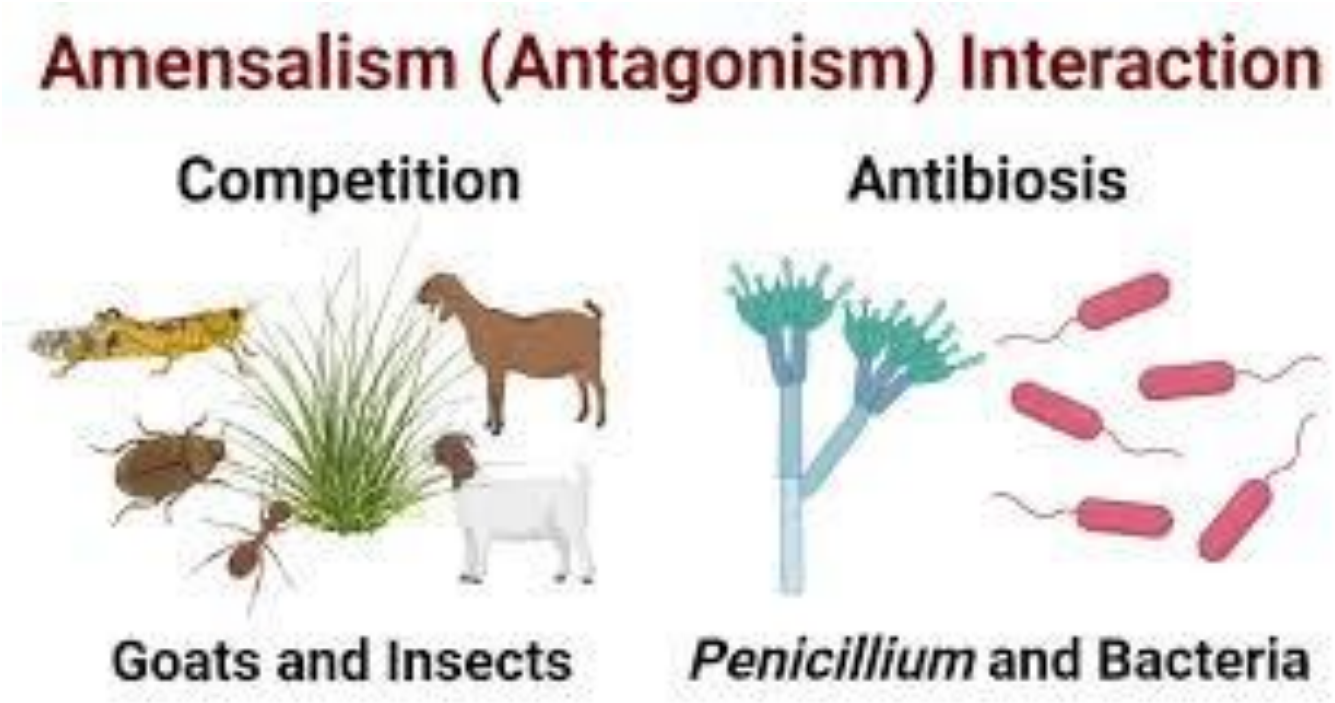


Figure showing Commensal bacteria cross talk with the host. Commensal bacteria supply the host with essential nutrients and defend the host against opportunistic pathogens.
They are involved in the development of the intestinal architecture and immunomodulatory processes.
On the other hand, the host provides the bacteria with nutrients and a stable environment.

Antagonism


Amensalism (Antagonism) Interaction
Competition
Antibiosis
Goats and Insects
Penicillium and Bacteria

Association of Microorganisms in Ecosystem

The inhibition of one bacterial organism by another. Through **microbial antagonism**, the normal bacterial flora of the body provides some defense against disease-causing organisms.

In phytopathology, **antagonism** refers to the action of any organism that suppresses or interferes with the normal growth and activity of a plant pathogen, such as the main parts of **bacteria** or fungi.

These organisms can be used for pest control and are referred to as biological control agents.

Figure 3. The isolated microorganism from *Prunus* spp. leaves (white colony) showed inhibition halos against *Staphylococcus* coagulase-positive strain in peptone agar (A) and yeast extract agar (B).

Antagonisms

Discovery of Penicillin antibiotic is one of the best example of Antagonism.

Antagonistic relationships

- The suppression or interference or inhibition with the normal growth of a microorganism by another microorganism, such as bacteria or fungi.
- Refers to the reduction in growth and activities of an organism as a result of the living of another organism.